hydroAMP
Asset Management Partnership

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asset management framework

USACE Asset Management Risk & Reliability Workshop
Alexandria, VA
August 15-18, 2006

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Hydro Québec

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

US Army Corps of Engineers

Bonneville Power Administration

The Beginning

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In 2001, the following four organizations joined together to form the hydropower Asset Management Partnership (aka hydroAMP):

- Bureau of Reclamation
- Hydro-Québec
- Corps of Engineers
- Bonneville Power Administration

Agreed to collaborate on these common goals:

- Improving the evaluation of hydropower equipment
- Prioritizing hydropower investment opportunities

The Need

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- Significant amount of critical equipment in hydro facilities in North America is near or beyond its design life.
- Equipment reliability significantly affects system generation availability and power production.
- Need for substantial investment to repair, refurbish, and/or replace existing equipment is anticipated.
- Opportunity exists to increase generation efficiency and capacity by investing in improved power plant equipment, control systems, and operations.

The Need (cont.)

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- Process for identifying and prioritizing investments needs strengthening.
- Establishment of an objective, consistent and valid assessment process is critical.
- Equipment condition assessment tools used in the past have been too complex and costly.

Asset Management Methodology

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- Develop Condition Assessment Guides for all major powerhouse equipment.
- Structure guides to facilitate use of FEMS/MAXIMO for data collection, storage, trending, and reporting.
- Develop Analysis Tools that use equipment condition, risk, and other factors to support and improve decision-making.

Condition Assessment Principles

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- Objective results
- Developed from routine tests and inspections
- Simplified process
- Easy interpretation
- Technically sufficient (valid though not necessarily perfect)
- Consistent and repeatable results
- Guided by multi-agency team effort
- Start small, expand with time
- Open to improvement

Condition Assessment: Two-Tier Approach

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Tier 1

- Based on tests, measurements, and inspections that are normally performed during routine O&M activities.
- Assessment results in a “Condition Index” with a scale of 1-10; higher CI means better condition.
- Mid- to low-range values may trigger Tier 2 evaluation.

Condition Assessment: Two-Tier Approach (cont.)

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Tier 2

- In-depth, non-routine tests or inspections that may be invasive and/or require specialized equipment and expertise not normally found at the project.
- Results are used to adjust the Condition Index score (either up or down).
- When performed, adds confidence to the assessment results and conclusions.

Framework Overview

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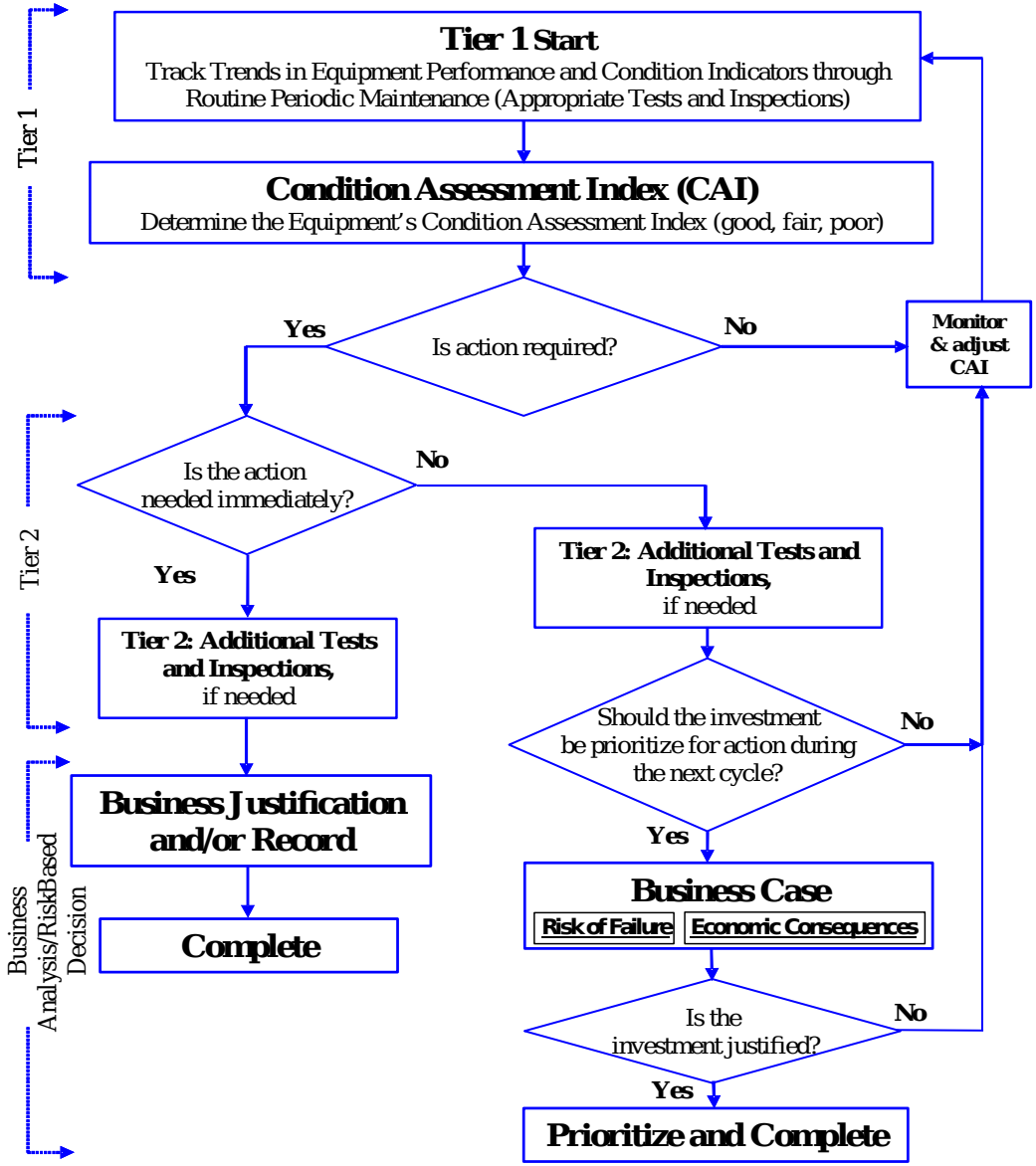

Business Application

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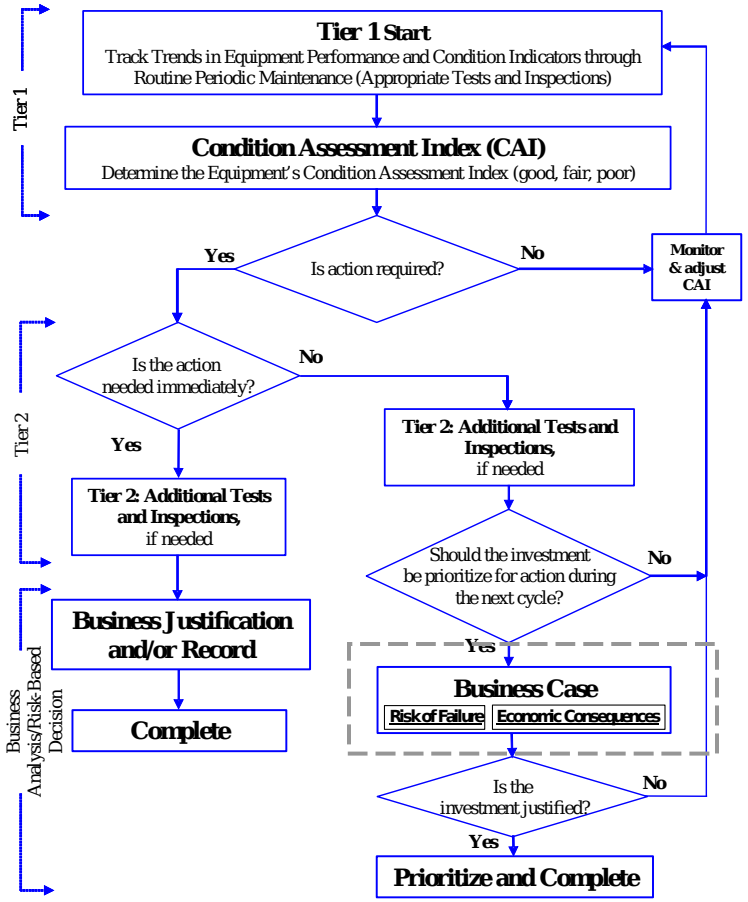

Business Case

Risk of Failure **Economic Consequences**

Analytical Approaches

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Analytical approaches vary in complexity:

- *Simple*
  - Considers equipment condition and cost alone.
  - Typically, this applies to less expensive equipment, such as compressors.
- *Risk-based*
  - Introduces additional factors that relate to financial and other consequences of undertaking or not undertaking a repair or replacement action.
  - The condition and consequence can be plotted on a risk matrix to inform investment decision-making.

Risk Matrix

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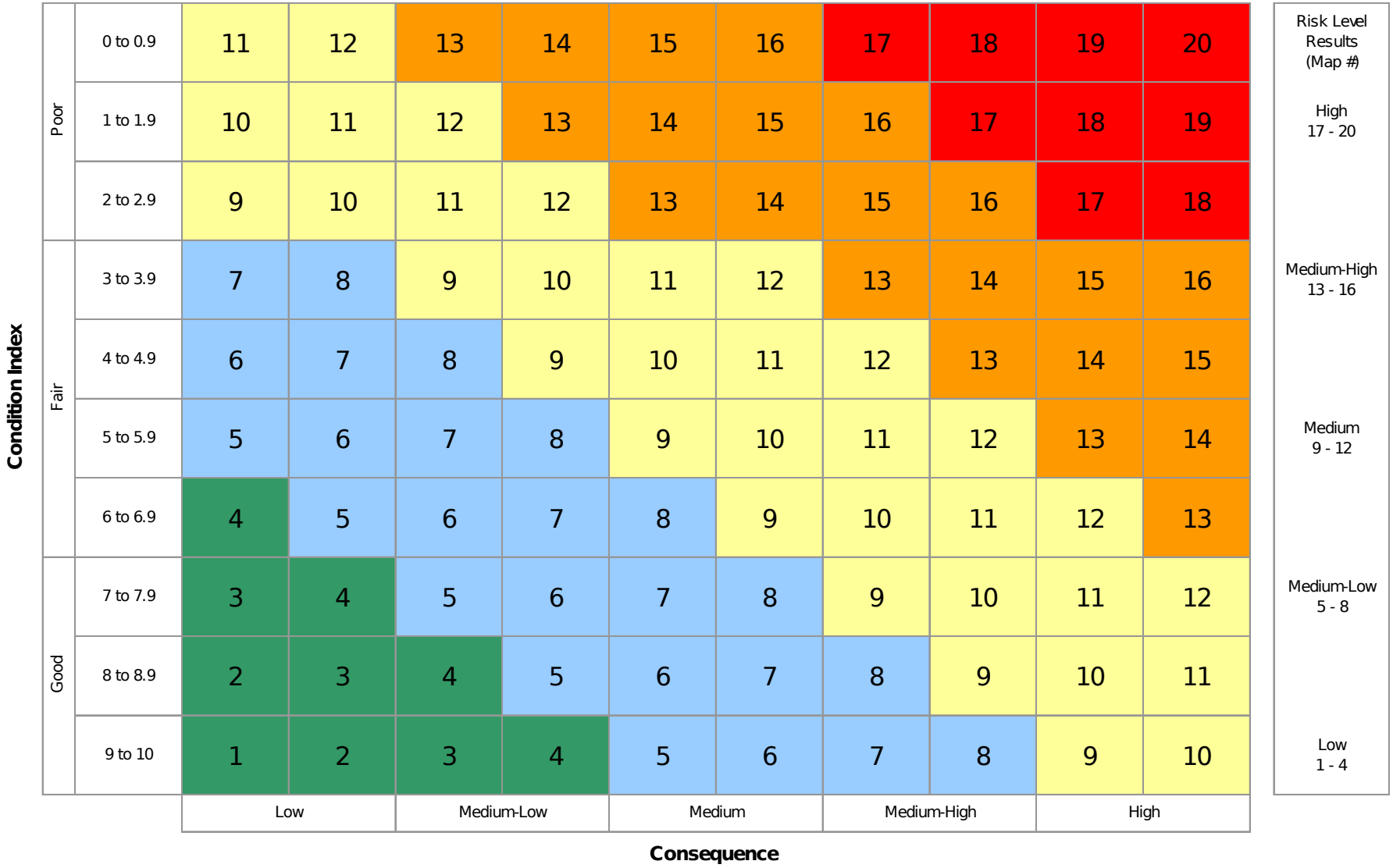

Application in the FCRPS

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- The Federal Columbia River Power System (FCRPS) includes 31 hydroelectric stations with a total of 209 generating units.
- Condition assessments have been performed on the following equipment:
  - Turbines
  - Generators
  - Governors
  - Exciters
  - Circuit Breakers
  - Transformers

Application in the FCRPS

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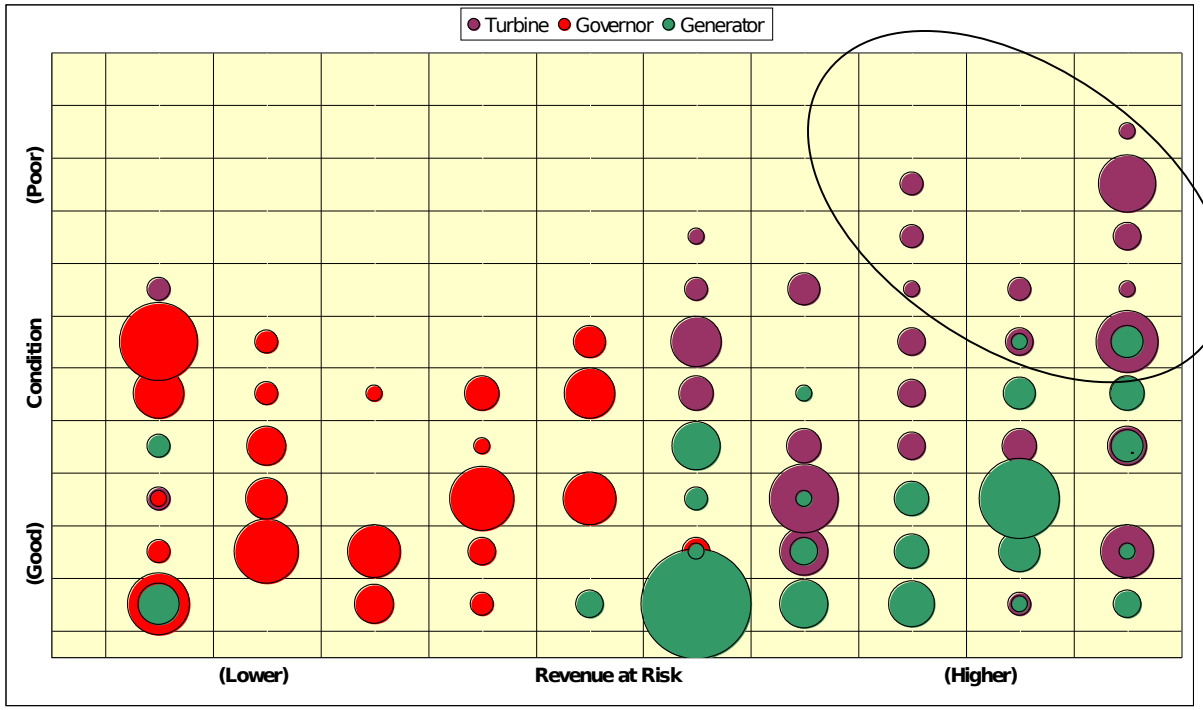

- Turbines present medium-high and high risk to asset performance, driven by a combination of low condition ratings and high lost revenues in the event of failure.
- Turbine condition ratings are largely related to age and physical condition. Age alone is not a concern. Runners are being replaced at several stations where blade cracking is a persistent problem.
- Governors and generators are in better condition and present less risk to power generation.

Application in the FCRPS (cont.)

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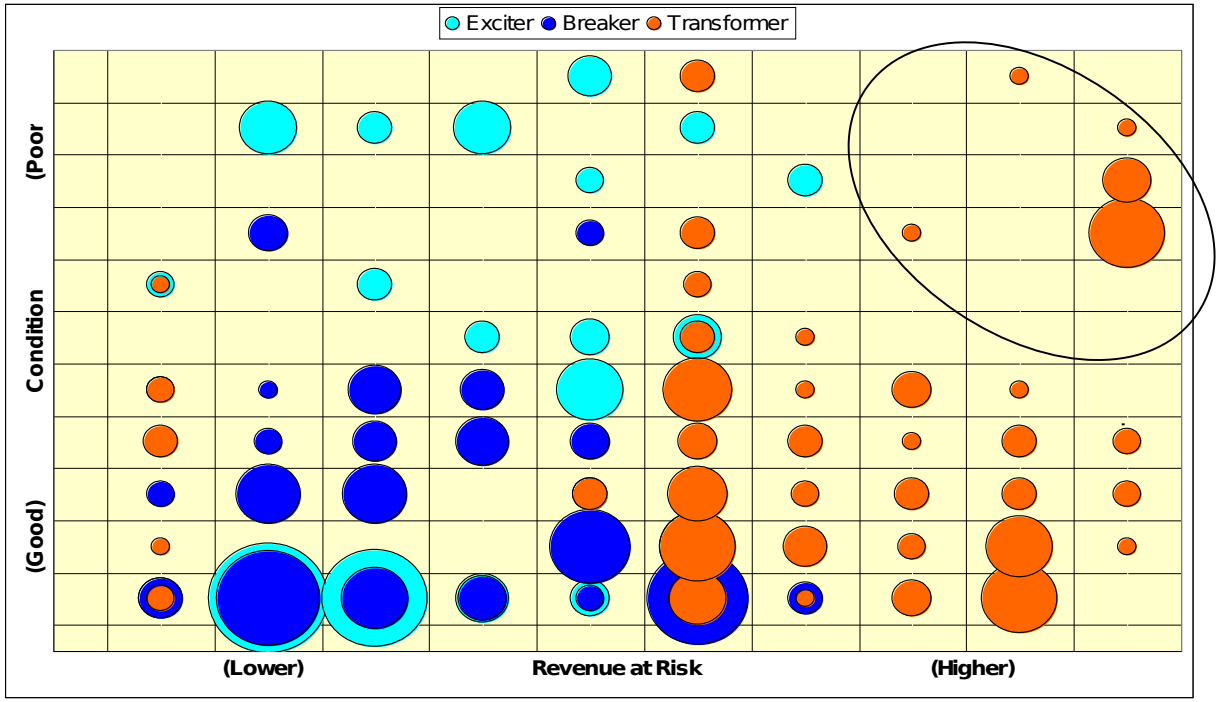

- Transformers also present medium-high and high risk to power generation. These risks are being managed by increasing monitoring, acquiring spares, and in some cases, replacement.
- Many exciters are also in poor condition, but present less risk because potential lost revenues are smaller. However, a systematic effort to replace exciters is underway, in part to address regulatory reliability requirements.
- The plot also shows generally good condition of breakers, the result of a system-wide replacement program now nearing completion.

Future Focus

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- The FCRPS is now moving beyond incremental investment decisions on individual pieces of equipment to a lifecycle view of the asset (i.e., power plant) as a whole.
  - Requires developing and documenting a long-term action plan for each station, and for the FCRPS as a whole, that maximizes the value of output relative to measurable strategic objectives.
  - Establishes strong links between those risks that affect the long-term financial performance of the asset and the actions required to mitigate them.
  - hydroAMP provides an objective, efficient, and transparent method for measuring equipment condition and understanding risk as it relates to that condition.

Future Focus (cont.)

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- Longer term, we see advantages in increasing both the utility participation rate and number of equipment types rated in the hydroAMP program.
- This has the benefit of improving the hydroAMP framework itself, allowing for broad-scale analyses of condition indices, trends, and ultimately to failure probability predictions. These, in turn, will support better business decisions.

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Thank you!

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